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(54) An electrical failure alarm

(57) An electrical failure alarm for providing warning of the failure of an electrical appliance (30) such as a refrigerator, freezer or incubator, which normally takes an intermittent supply, comprises a detector (10) arranged to detect when the appliance (30) is not taking current from the main supply (25) and then to produce an output, *e.g.* from a rechargeable battery, which is not dependent on the mains supply, electrical charge storage means, such as a resistance-capacitance network or a timer circuit (200) incorporating a capacitor (220), arranged to receive the output (if any) from the detector (10) and to produce a signal if the output from the detector has continued for more than a predetermined time, thus indicating a fault, and at least one alarm device, *e.g.* an audible alarm (450) and a visual alarm (490), arranged to be activated by such a signal. A second timer circuit (300) may be fed with the inverted output from the detector (10) so as to produce an alarm signal if the appliance has continued to take current for more than a predetermined time, which would also indicate a fault. Where the appliance (30) is, say, a freezer the predetermined time may be varied as a function of ambient temperature, to reflect the expected variations in the freezer operations.

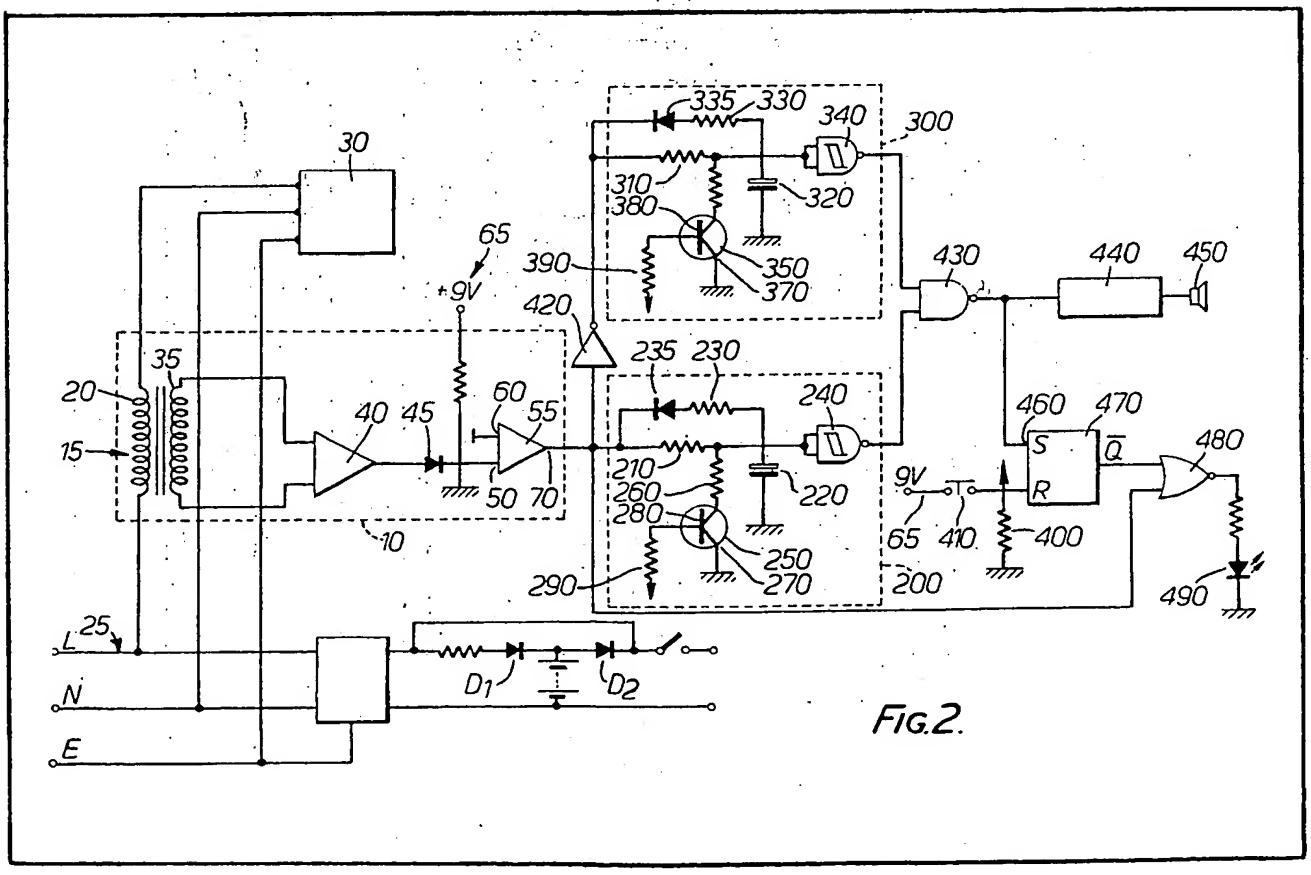

FIG.2.

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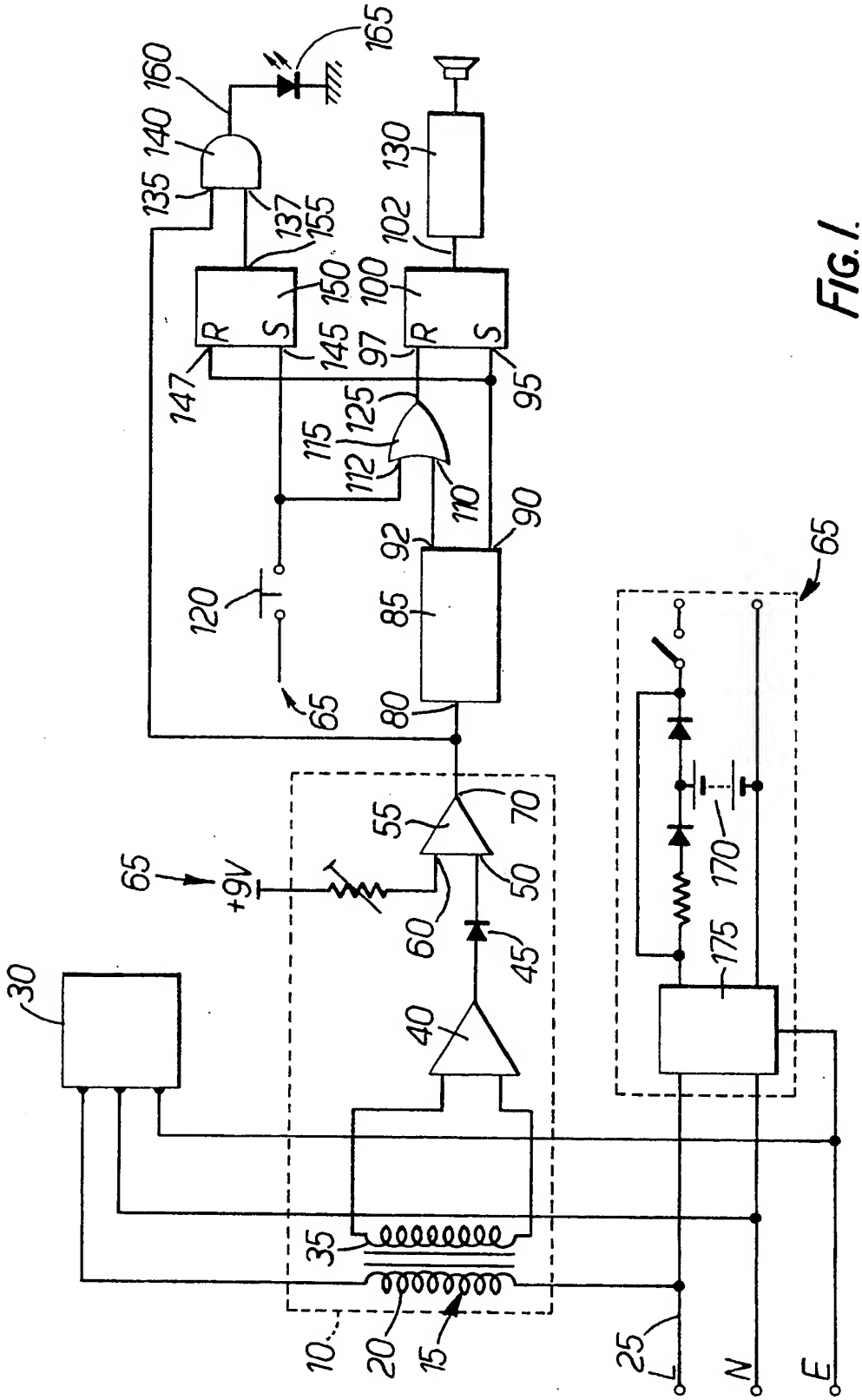
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FIG. 1.

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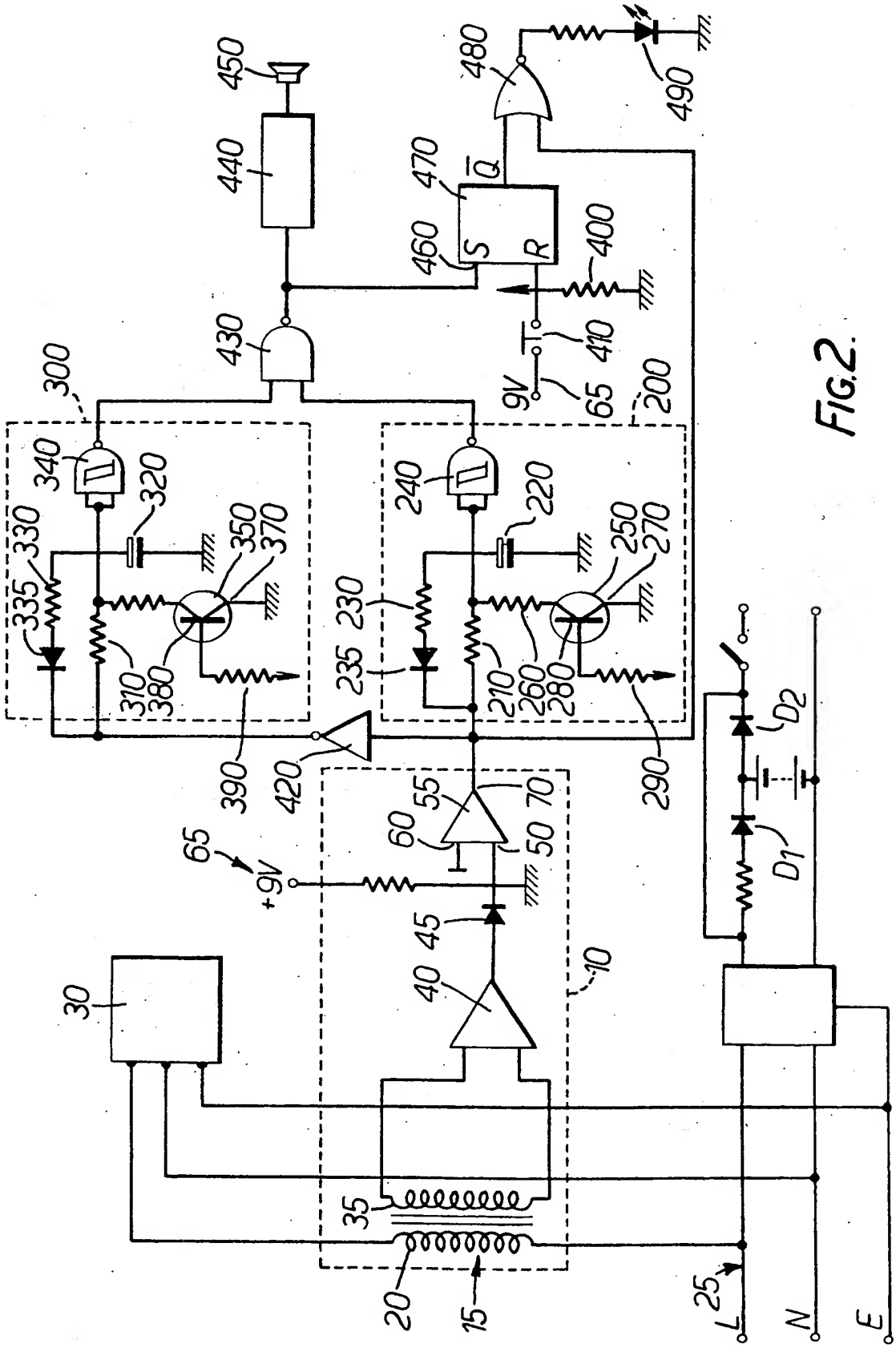
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FIG.2

SPECIFICATION

An electrical failure alarm

This invention relates to an electrical failure alarm for providing warning of the failure of an electrical appliance which normally takes an intermittent supply of current.

A problem with electrical appliances which consume electricity on an intermittent basis, *e.g.* refrigerators, freezers and incubators, is that it is not possible to use normal warning devices for providing warning of failure of either the supply or the appliance. This is because such warning devices would normally be activated as soon as the appliance stopped taking current since with appliances which take a constant supply this would indicate failure. However freezers, refrigerators etc. necessarily do not take current continuously and may not do so for several hours. An object of the present invention is to provide an electrical failure alarm for an electrical appliance which takes an intermittent supply of current, which alarm will allow for the appliance not taking current for a predetermined period but will be activated if the appliance fails to resume taking current after the predetermined period, as a result of breakdown of the appliance or failure of the power supply for any reason. A further optional refinement is to arrange for activation of the alarm if the appliance takes a continuous supply of current for an excessive time, which would also represent a fault condition.

According to the present invention there is provided an electrical failure alarm for providing warning of a failure of an electrical appliance which normally takes an intermittent supply of current, the alarm comprising a detector arranged to detect when the appliance is not taking current from the mains supply and then to produce an output which is not dependent on the mains supply, electrical charge storage means arranged to receive the output (if any) from the detector and to produce a signal if the output from the detector has continued for more than a predetermined time, and at least one alarm device connected to the output from the charge storage means so as to be activated by such a signal.

Thus the alarm device or devices will only be activated if the appliance has not taken any current for a period longer than the predetermined time, which can be set according to the normal non-current-taking period of the particular appliance. Since the detector output is not dependent on the main supply, the activation of the alarm device or devices is not affected by mains supply failure and an alarm will be given whether the failure is in the appliance or in the mains supply. Preferably there are two such alarm devices, one providing a visual signal and one an audible signal.

Preferably the detector comprises an inductance means, having one winding connected in the main supply to the appliance and the other winding connected *via* an amplifier and a rectifier to one input of a comparator whose other input is connected to a constant voltage supply which is not dependent on the mains supply, said comparator giving an output current only when the two input signals differ, *i.e.* when the appliance is not taking current.

The output from the detector may be connected to the input of a resistance-capacitance network, which serves as the charge storage means, the resistance-capacitance network charging up for the predetermined time while there is an output from the comparator, after which the resistance-capacitance network produces a discharge to activate the alarm device or devices.

One output from the resistance-capacitance network may be connected to the setting input of a latch and a second output from the resistance-capacitance network connected to one input of an OR gate, the said constant voltage supply being connected *via* a normally open re-set switch to a second input of said OR gate, and the output of said OR gate is connected to the re-set input of said latch, so that when the resistance-capacitance network discharges the latch receives an input signal at its setting input and so gives an output current, the output from the latch being connected to the alarm device or one of the alarm devices so as to activate it, while on closing the re-set switch after discharge of the resistance-capacitance network the latch is re-set through the OR gate.

In a specific arrangement, the output from the detector is additionally connected to one input of an AND gate, the said one output from the resistance-capacitance network is additionally connected to the setting input of a second latch, and the said constant voltage supply is additionally connected *via* the re-set switch to the re-set input of the second latch, the output from said second latch being connected to a second input of said AND gate so that when the resistance-capacitance network discharges, there is an input signal to the setting input of said second latch which gives an output signal, the said AND gate thus receives input signals at both inputs and so gives an output signal, the output of said AND gate being connected to a second alarm device so as to activate it.

Preferably the first-mentioned alarm device is an audible pulsed-tone alarm and said second alarm device is a visual alarm.

In another form of the invention, the output from the detector is connected to a capacitor which serves as the charge storage means and which forms part of a timer circuit incorporating a trigger device and arranged to produce an output to activate an alarm device when the potential at the capacitor reaches a threshold value. In this case, the output from the timing circuit may also be connected to the setting input of a latch whose inverted output is fed to a NOR gate which also receives the output from the detector, the output from the NOR gate being used to activate a visual alarm when the timer circuit has been triggered but the appliance has resumed taking current.

Preferably there are two such timer circuits identical with one another and connected to the first-mentioned alarm device through a gate which passes signals from either timer circuit, the second timer circuit being fed with the inverted output from the detector to provide an alarm if the appliance takes current for an excessive period.

Advantageously the constant voltage supply which is not dependent on the mains comprises a transformer which is connected to the mains and a rechargeable battery fed from the transformer.

In the case of failure of the appliance itself, provisions may be made for small amounts of currents, *e.g.* lights or other auxiliaries, not to interfere with the operation of the device.

The alarm will be activated if the power supply fails for any reason such as mains failure, blown fuse, plug displaced from its socket, bad connection, appliance inadvertently switched off, etc.

The alarm may be constructed as a small unit which can be built into a case which will incorporate a three pin plug and so can be connected to an appliance lead in the same way as a normal three pin plug.

Alternatively the alarm may be constructed as a unit separate from the appliance or its plug, or it may be incorporated into the appliance.

Specific embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 shows diagrammatically the circuit of an electrical failure alarm to provide warning when an appliance has ceased to take current for longer than a predetermined time, and

Figure 2 is a similar circuit diagram of an electrical failure alarm for providing such a warning and, in addition, warning if the appliance continues to take current for longer than a predetermined time.

The electrical failure alarm of Figure 1 comprises a detector 10 comprising an inductance means 15, having one winding 20 connected in the mains supply 25 to an appliance 30 and the other winding 35 connected via an amplifier 40 and a rectifier 45 to one input 50 of a comparator 55 whose other input 60 is connected to a constant voltage supply 65 which is not dependent on the mains supply 25. The voltage of supply 65 is equal to the normal output from rectifier 45 when the appliance 30 is taking current. The comparator 55 gives an output current only when the two input signals differ, *i.e.* when the appliance 30 is not taking current.

The output 70 from the comparator 55 is connected to the input 80 of a resistance-capacitance network 85 which serves as a charge storage means. The resistance-capacitance network 85 charges-up for a predetermined time while there is an output current from the comparator 55, after which the resistance-capacitance network 85 produces a discharge.

One output 90 of the resistance-capacitance network 85 is connected to the setting input 95 of a latch 100. The latch 100 comprises a bistable flip-flop device which acts as a switch for allowing current to flow depending upon the state of the previous components in the circuit. A second output 92 from the resistance-capacitance network 85 is connected to one input 110 of an OR gate 115. The constant voltage supply means 65 can be connected *via* a normally open re-set switch 120 to a second input 112 of the OR gate 115. The output 125 from the OR gate 115 is connected to the re-set input 97 of latch 100. When the resistance-capacitance network 85 discharges and the re-set switch 120 is in the open position, there is an input signal to input 110 only of the OR gate 115 which gives an output signal. The inputs 95 and 97 of the latch 100 therefore both receive input signals and the latch 100 switches to its conducting state and so gives an output signal. The output 102 of the latch 100 is connected to an audible pulsed-tone alarm 130 which is activated thereby.

The output 70 of the comparator 55 is additionally connected to one input 135 of an AND gate 140. Also the constant voltage supply 65 can be additionally connected *via* the re-set switch 120 to the re-set input 145 of a second latch 150. The output 90 from the resistance-capacitance network is also connected to the setting input 147 of latch 150. When the resistance-capacitance network discharges and the re-set switch 120 is in the open position the setting input 147 of latch 150 receives an input signal and the latch 150 switches to its conducting state and so gives an output signal, the output 155 of latch 150 being connected to a second input 137 of AND gate 140. Since both inputs 135 and 137 of AND gate 140 thus receive input signals it gives an output signal, the output 160 of the AND gate 140 being connected to a visual alarm 165 in the form of an LED device which is activated thereby.

When the resistance-capacitance network 85 has fully discharged, it will provide a signal to input 110 of the OR gate 115 which will pass a signal to the re-set input 97 of latch 100 which switches off, so that the pulsed-tone alarm 130 will stop sounding. The latch 150, however, continues giving an output signal since only the input signal to input 147 stops, which does not affect the state of the latch. Therefore the visual alarm 165 stays activated as an indication that the alarm has been triggered.

If it is desired to switch the alarm off during or after the discharging period of the resistance-capacitance network, the re-set switch 120 may be closed to provide input signals to re-set input 95 of latch 100 and re-set input 145 of latch 150. These two inputs cause the latches to stop giving an output which in turn stops the two alarms.

The constant voltage supply 65 comprises a transformer 175 which is connected to the mains 25 and a rechargeable battery 170 fed from the transformer. The battery 170 is thus constantly recharged during normal operation and so will provide the constant voltage independently of the

mains 25 for a considerable period should there by a failure in the power supply.

The electrical failure alarm will give warning of failure of either the appliance itself or of the power supply for any reason, *e.g.* mains failure, blown fuse, plug out of socket, bad connnection, etc., since the winding 20 of the inductance means 15 is connected in the mains line between the mains 25 and the appliance 30 and so detects the flow of current along this line.

In the embodiment of Figure 2, the detector 10 is the same as in Figure 1, so that its output at 70 is high when the appliance 30 is not taking current but low when it is taking current. The resistance-capacitance network 85 of Figure 1 is replaced in Figure 2 by two timing circuit essentially identical to one another, namely a "time-off" circuit 200 to measure the time the appliance does not take current and a "time-on" circuit 300 to measure the time it does take current.

In the time-off circuit 200, the output 70 of the comparator 55 is connected through resistor 210 to one side of a capacitor 220 whose other side is earthed and which serves as a charge storage means. A parallel connection through resistor 230 (which is of lower resistance than resistor 210) and rectifier 235 allows for rapid discharging of capacitor 220 when the output of the comparator is low. The capacitor 220 is also connected to a Schmitt trigger 240 whose output goes low when the potential at capacitor 230 reaches a predetermined threshold value, *i.e.* after the appliance 30 has not been taking current for a predetermined period. For re-setting purposes, a transistor 250 has one pole connected through a resistor 260 to the capacitor 220, a second pole 270 connected to earth and its base 280 connected through resistors 290 and 400 to earth. A normally open re-set switch 410 can connect the constant voltage supply 65 (which is the same as in Figure 1) between resistors 290 and 400, so as to switch the transistor 250 into saturation and allow the capacitor 220 to discharge through resistor 260 and pole 270 to earth.

The time-one circuit 300 is identical to the time-off circuit 200 but is provided with the inverted output of comparator 55 through an inverter 420. The elements of circuit 300 are identified by corresponding numerals to those of circuit 200 but with the first figure 3 instead of 2. The resistor 400 and re-set switch 410 are common to both time circuits.

The outputs of both timer circuits are fed to a NAND gate 430 whose output goes high if the output of either timer circuit goes low, thus indicating that the appliance 30 either has not been taking current for too long, or that it has been taking current for too long. If the fault condition is reversed, the capacitor of the respective timer circuit is discharged and the output from the NAND gate 430 goes low again.

The output from the NAND gate 430 actuates a pulsed tone alarm generator 440 which in turn drives a piezo-electric buzzer 450 to provide an audible alarm so long as the fault condition persists. The current actuating the tone generator 440 is taken from the constant voltage supply 65 *via* the comparator 55 and the respective timing circuit 200 or 300, and is thus not dependent on the main supply.

The output from the NAND gate 430 is also connected to the setting input 460 of a latch 470. The inverted output from the latch 470, and the output 70 of the comparator 55 are connected to a NOR gate 480 whose output is high only when both inputs are low. The output of NOR gate 480 is connected to an LED device 490, which is thus not actuated to provide a visual alarm unless the appliance 30 is taking current and one of the timer circuits 200 or 300 has been actuated to produce an alarm. Thus if the time-off circuit 200 has been actuated but the appliance 30 has started to take current again, the visual alarm will show that the alarm has been triggered. If the time-on circuit 300 has been actuated, the visual alarm will show that the fault being indicated by the audible alarm is that current has been taken for too long. If the appliance then ceased to take current for a time, the visual alarm will be actuated again when it resumes taking current until the latch 470 has been re-set. The re-set input 490 of the latch can be connected by the re-set switch 410 to the constant voltage supply 65 for this purpose. With this arrangement, the visual alarm is not actuated on failure of the mains supply 25 and thus does not put an additional drain on the battery 170 in such circumstances.

Various changes may be made in the circuitry of the apparatus without departing from the scope of the invention. For example, the detector 10 may incorporate a low value resistor (say 1/100 ohm) in the supply line 25 in place of the winding 20, leads being taken from either side of the resistor to the amplifier 40 so as to sense and amplify the voltage drop across the resistor which appears when the appliance 30 is taking current and to supply this to the input 50 of the comparator 55.

Variations in the lengths of periods of consumption of current by the appliance may occur with variations in ambient temperature. For example, a freezer which is kept in an unheated garage will consume less current in winter than in summer. The alarm may therefore include a temperature sensor arranged to adjust the predetermined time after which an alarm signal will be produced in dependence on the ambient temperature.

Claims (Filed on 7 Dec 83)

1. An electrical failure alarm for providing warning of the failure of an electrical appliance which normally takes an intermittent supply of current, the alarm comprising a detector arranged to detect when the appliance is not taking current from the main supply and then to produce an output which is not dependent on the mains supply, electrical charge storage means arranged

to receive the output (if any) from the detector and to produce a signal if the output from the detector has continued for more than a predetermined time, and at least one alarm device connected to the output from the charge storage means so as to be activated by such a signal.

2. An electrical failure alarm according to claim 1, wherein there are two such alarm devices, one providing a visual signal and one an audible signal.

3. An electrical failure alarm according to claim 1 or 2, wherein the detector comprises an inductance means, having one winding connected in the main supply to the appliance and the other winding connected *via* an amplifier and a rectifier to one input of a comparator whose other input is connected to a constant voltage supply which is not dependent on the mains supply, said comparator giving an output current only when the two input signals differ, *i.e.* when the appliance is not taking current.

4. An electrical failure alarm according to claim 3, wherein the output from the detector is connected to the input of a resistance-capacitance network, which serves as the charge storage means, the resistance-capacitance network charging up for the predetermined time while there is an output from the comparator, after which the resistance-capacitance network produces a discharge to activate the alarm device or devices.

5. An electrical failure alarm according to claim 4, wherein one output from the resistance-capacitance network is connected to the setting input of a latch and a second output from the resistance-capacitance network is connected to one input of an OR gate, the said constant voltage supply is connected *via* a normally open re-set switch to a second input of said OR gate, and the output of said OR gate is connected to the re-set input of said latch, so that when the resistance-capacitance network discharges the latch receives an input signal at its setting input and so gives an output current, the output from the latch being connected to the alarm device or one of the alarm devices so as to activate it, while on closing the re-set switch after discharge of the resistance-capacitance network the latch is re-set through the OR gate.

6. An electrical failure alarm according to claim 5, wherein the alarm device which receives the output from the latch is an audible pulsed-tone alarm.

7. An electrical failure alarm according to claim 5 or 6, wherein the output from the detector is additionally connected to one input of an AND gate the said one output from the resistance-capacitance network is additionally connected to the setting input of a second latch, and the said constant voltage supply is additionally connected *via* the re-set switch to the re-set input of the second latch, the output from said second latch being connected to a second input of said AND gate so that when the resistance-capacitance network discharges, there is an input signal to the setting input of said second latch which gives an output signal, the said AND gate thus receives input signals at both inputs and so gives an output signal, the output of said AND gate being connected to a second alarm device so as to activate it.

8. An electrical failure alarm according to claim 7, wherein said second alarm device is a visual alarm.

9. An electrical failure alarm according to any one of claims 1 to 3, wherein the output from the detector is connected to a capacitor which serves as the charge storage means and which forms part of a timer circuit incorporating a trigger device and arranged to produce an output to activate an alarm device when the potential at the capacitor reaches a threshold value.

10. An electrical failure alarm according to claim 9 wherein the output from the timing circuit is also connected to the setting input of a latch whose inverted output is fed to a NOR gate which also receives the output from the detector, the output from the NOR gate being used to activate a visual alarm when the timer circuit has been triggered but the appliance has resumed taking current.

11. An electrical failure alarm according to claim 9 or 10, wherein there are two such timer circuits identical with one another and connected to the first-mentioned alarm device through a gate which passes signals from either timer circuit, the second timer circuit being fed with the inverted output from the detector to provide an alarm if the appliance takes current for an excessive period.

12. An electrical failure alarm according to any one of claims 3 to 11, wherein the constant voltage supply which is not dependent on the mains comprises a transformer which is connected to the mains and a rechargeable battery fed from the transformer.

13. An electrical failure alarm according to any one of the preceding claims, constructed as a unit built into a case incorporating a three pin plug.

14. An electrical failure alarm according to any one of claims 1 to 12, which alarm is incorporated into the appliance.

15. An electrical failure alarm for providing warning of the failure of an electrical appliance which normally takes an intermittent supply of current, substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawings.

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